

Name(s): \_\_\_\_\_

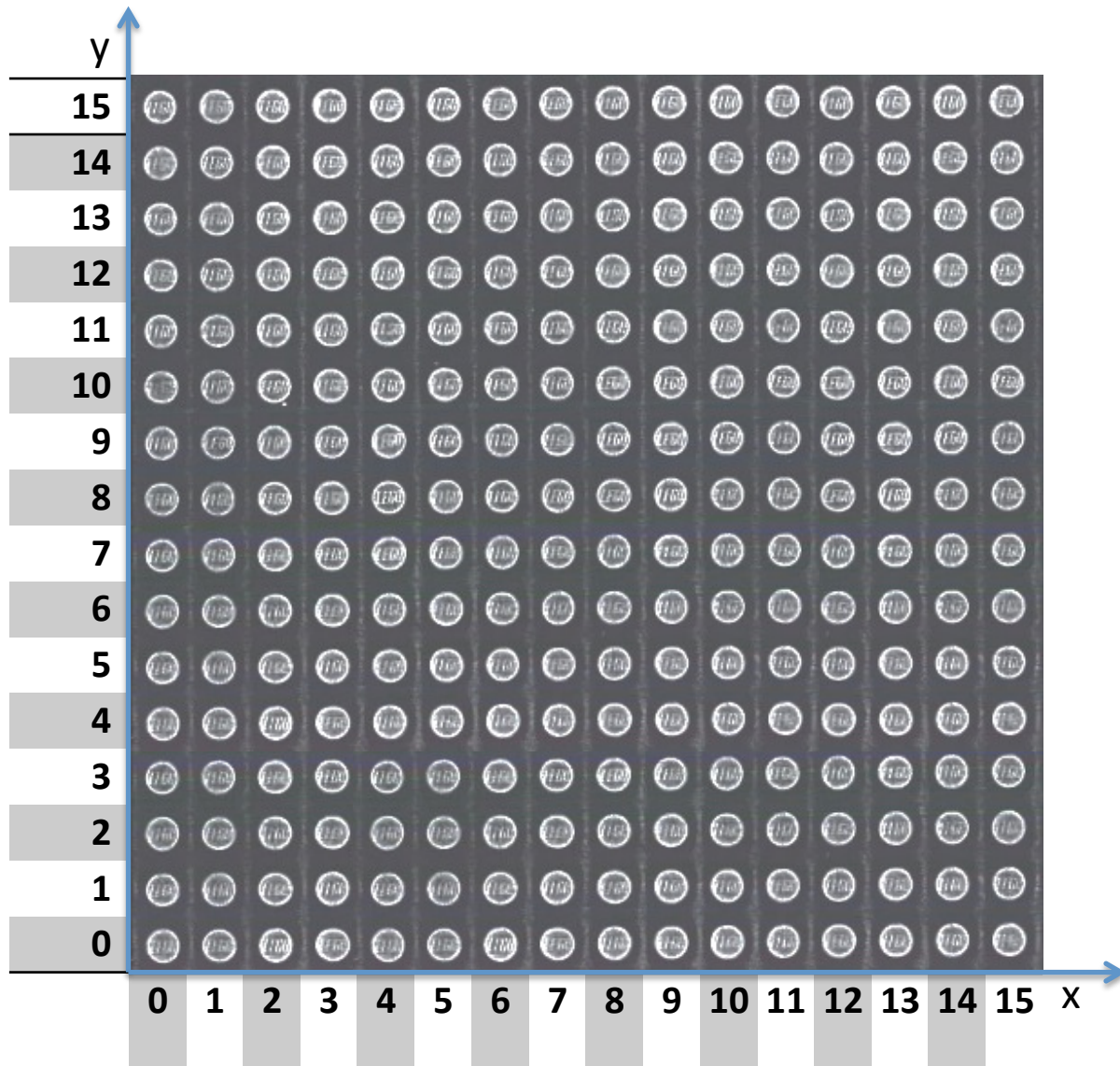
# Secret Fortress Construction Challenge

You should have two identical LEGO block kits. Set the extra kit aside, and use one kit to build a LEGO fortress:

1. Find a secluded spot to build your *secret* fortress. Don't let anyone else see it!
2. Place your 16x16 base piece on top of the template on page 2. The *template* gives you the *position coordinates* for your LEGO fortress.
3. Construct your fortress on this base piece. As you go, fill in Chart A on page 3 to make a set of *building instructions*: the first piece you put down is block 0, the next one is block 1, and so on. For each piece, write down the brick's color, type, orientation, and position coordinates of the bottom left corner.
4. When you're done with Chart A, fill in the legend on the same page: create a *binary encoding* for all the brick colors, types, orientations, and numbers you used. Copy this legend onto page 4 as well.
5. Using your legend, *translate* Chart A by *encoding* all the information in binary to fill in Chart B. You can fold Chart B along the vertical dotted lines to make it easier to copy: line up the original information with the empty slot for the encoded information, and translate!
6. Give page 4 (your legend and Chart B) and your extra kit of LEGO blocks to the other team. Don't let them see your original structure or Chart A! They'll give you *their* instructions and extra blocks, too!
7. Copy their legend onto page 5. Then, use this legend to *decode* their binary building instructions in Chart C.
8. Once you've decoded the instructions from binary, try to rebuild their secret fortress!
9. When both teams are done, compare the fortresses you've created. Were you successful? Why or why not? If something went wrong, which step was wrong?

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# Secret Fortress Base Template



# Your Legend

Color	
Red	001
Brick Type	
2 x 4	010100
Orientation	
Horizontal	00
Vertical	01
Numbers	
1	001
2	010
3	011
4	100
5	101
6	110

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Fill in the chart below with *instructions* for building your fortress. You can think about reading this as “put the sample block, which is a **red 2x4** block, horizontally, with its bottom left corner at the position given by the x-coordinate **6** and the y-coordinate **4**.”

Then, fill in the legend to create an encoding for all the brick descriptions. For example, a 2x4 block can be represented with 010100, since 010 is 2 in binary, and 100 is 4 in binary. Get creative!

### Chart A. Original Building Instructions

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Block	Color	Brick Type	Orientation	X	Y
Sample	Red	2x4	Horizontal	6	4
0					
1					
2					
3					
4					
5					
6					
7					
8					

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# Your Legend

Color	
Red	001
Brick Type	
2 x 4	010100
Orientation	
Horizontal	00
Vertical	01
Numbers	
1	001
2	010
3	011
4	100
5	101
6	110

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Using the legend you've created on the last page, *translate* the instructions in Chart A to binary.

This is similar to what a computer might do when you give it some information through a key press or a mouse click. Converting information into binary allows the computer to represent it as the absence (0) or presence (1) of an electric signal.

## Chart B. Binary Building Instructions

Block	Color	Brick Type	Orientation	X	Y
Sample	001	010100	00	110	100
0					
1					
2					
3					
4					
5					
6					
7					
8					

# Their Legend

Color	
Red	001
Brick Type	
2 x 4	010100
Orientation	
Horizontal	00
Vertical	01
Numbers	
1	001
2	010
3	011
4	100
5	101
6	110

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Copy the other team's legend in the space provided, then decode their binary instructions back into words and base-10 numbers. Once you've decoded all their instructions, try following their instructions to rebuild their fortress!

Chart C. Translated Building Instructions

Block	Color	Brick Type	Orientation	X	Y
Sample	Red	2x4	Horizontal	6	4
0					
1					
2					
3					
4					
5					
6					
7					
8					

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**Additional Exercise:**

What if you had converted your table of binary instructions into a line of 0s and 1s? For example, for these sample blocks,

Block	Color	Brick Type	Orientation	X	Y
0001	001	010100	00	110	100
0010	010	101101	01	111	100

We end up with:

000100101010000110100001001010110101111100

Try it out! Write your building instructions as *just* a line of 0s and 1s:

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In this system, each block is represented by a series of 21 binary digits, or “bits”. We can tell the computer that every 21 digits represents a new LEGO block and that the first 4 digits represent block number, and so on. We can also tell it what all of the numbers mean—we can tell it how to *decode*, and the computer can use this long line of numbers to carry out a set of instructions and build a LEGO tower.

In computer science, a sequence of characters, like this line of 0s and 1s, is called a *string*. Strings can represent some kind of information or instructions. A sentence can be a kind of string, too!